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EDGEWOOD ARSENAL CONTRACTOR REPORT

EM-CR-76011

EA-5711

INCIDENT/ACCIDENT SURVEY
(1950 THROUGH 1974)

by

Fred L. McIntyre

December 1975

NATIONAL SPACE TECHNOLOGY LABORATORIES
General Electric Company
Engineering and Science Services Laboratory
Bay St. Louis, Mississippi 39520

Contract No. NAS8-27750

DEPARTMENT OF THE ARMY
Headquarters, Edgewood Arsenal
Aberdeen Proving Ground, Maryland 21010

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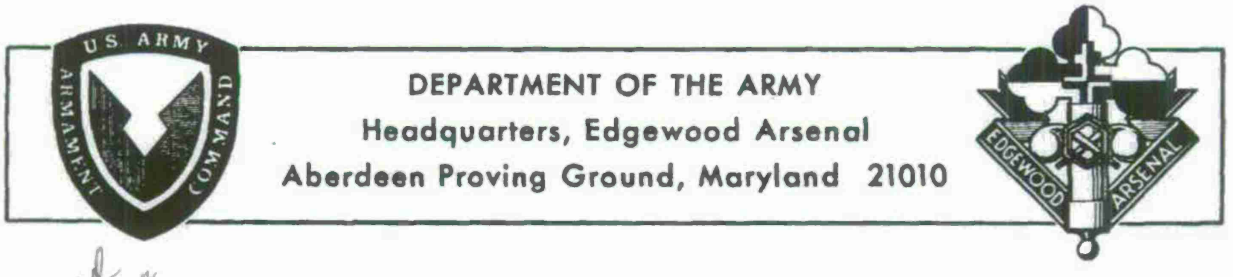

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Accident reporting
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The initial undertaking was limited to a literature survey of accident/incident summaries of various reporting agencies. It was not intended to pit one facility/organization versus the next, but to generate a maximum amount of data in the shortest time to be utilized in statistical inferences and to provide input for fault-tree type analysis per MIL STD 882 and AMCR 388-4. Specifically, this survey was interested in manufacturing operation and pyrotechnic incidents/accident, but the final format and data amassed included propellant, fuzes, primers, high explosives, intermediate constituents, and end items.

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PREFACE

The investigation described in this report was authorized under PEMA 4932 Project No. 5751249, MIPR B5041, and TWR EA-5711. It was performed at the NASA National Space Technology Laboratories (NSTL) for the Edgewood Arsenal Resident Laboratories (EARL) and NASA-NSTL by the General Electric Company under Contract No. NAS8-27750. The survey work was reported through May 30, 1975.

Acknowledgement

The author acknowledges the assistance of L. T. Morris, P. V. King, Dr. R. Schmidt, W. R. Wilcox of Engineering and Science Services Laboratory of General Electric and Dr. G. L. McKown of the Edgewood Arsenal Resident Laboratory.

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INCIDENT/ACCIDENT SURVEY

(1950 THROUGH 1974)

1.0 INTRODUCTION

1.1 Objective. The objective of this survey was to determine cause/effect relationships and to identify primary hazards throughout the life cycle of hazardous materials including: propellants, explosives, and pyrotechnics.

1.2 Authority. The investigation described in this report was authorized under PEMA 4932, Project No. 5751249, MIPR B5041, and Technical Work Request No. EA-5711. It was performed for the Edgewood Arsenal Resident Laboratory (EARL) at the National Space Technology Laboratories (NSTL) by the General Electric Company under Contract NAS8-27750.

1.3 Background. In an attempt to identify primary hazards associated with manufacturing processes a cursory incident/accident survey was undertaken. The current effort was limited in scope to determine:

- Sources of readily available data
- Criteria governing the publishing of incident/accident information
- The present format of available data
- What cause/effect relationships could be obtained

The preliminary investigation covers a period from 1950 through 1974.

2.0 TECHNICAL APPROACH

2.1 Literature Survey. The initial undertaking was limited to a literature survey of accident/incident summaries of various reporting agencies, i.e.; Department of Defense Explosives Safety Board (DODESB), Army, Air Force, Navy, Institute of Makers of Explosives, and Department of Transportation (DOT). The difficulty in addressing such agencies and establishing the need-to-know limited the sources to those agencies which would readily provide the data or allow Edgewood Arsenal Resident Laboratory's contractor to physically review the pertinent information.

2.2 Field Survey. From the outset it was evident that the majority of incident/accident data was not published. To determine cause/effect relationships it was necessary to make field trips to "GO-GO" and "GO-CO" facilities and gather the data first-hand. To facilitate expediency and exactness of reporting, and to prevent duplication of data, a simple form

was developed to collect the data in the following format:

Type Incident	Severity of Incident	Function	Stimulus	Cause	Material	Date	Ref.
Explosion	Minor	Manufacture Mixing	Electro-static	Failed To	Pyrotech-nic Flare Mix	5/11/72	NSTL

Utilizing this type of a format it was possible to gather sufficient data to record the incident, codify at a later date, with minimum impact to the operation. The purpose of the field survey was not intended to pit one facility against another but to generate a maximum amount of data, in the shortest possible time, that could be used in statistical inferences and provide input for fault-tree type analysis per MIL STD 882 and AMCR 388-4.

Specifically this survey was geared to manufacturing operations and pyrotechnic incidents/accidents, however the final format and data amassed included propellant, fuzes, primers, high explosives intermediate constituents, and end items.

3.0 FINDINGS

3.1 Literature Survey. There are readily available sources of accident/incident data. DODESB is a prime source of abstracted data of those incident/accidents that require publication. However, this constitutes a small fraction of a given year total accidents/incidents inclusive of all of those that would not normally be reported. Safety offices of individual GO-GO and GO-CO plants seem to provide the most factual and complete data and constitute the single largest source of available data. Although readily accessible it is not in the desired format for immediate use and must be obtained by physical on-location cataloging. The Army, Navy, and Air Force have established independent reporting agencies where a myriad of amassed statistical data is on file. To obtain the data one must establish the need-to-know and address the proper agency for a specific type of information before it is readily available. Data from other Government agencies such as Defense Contract Administration Services (DCAS), Department of Transportation, and Department of Labor (Occupational Safety and Health Act (OSHA) related statistics), supplied upon establishing a need-to-know and payment for reproduction costs, are of the same general nature and are usually to abstracted to be of value in addressing the problem. Data from these agencies are often duplicated depending upon the nature of the event. The Institute of Makers of Explosives represents a source of information from private manufacturers at on plant locations. Insurance companies and societies offer additional sources.

3.2 Reporting of Incident/Accident Records. Personal contact in the field with various arsenals tend to indicate that the major portion of incidents/accidents are not reported forward. Rather the published incidents are limited to those requiring any extensive investigation. A physical survey at each location is warranted.

3.3 Formatting of Available Information. Standard reporting forms for accident and incident and published accident/incident abstracts are very qualitative in nature primarily furnishing incident case history, financial losses, and injuries incurred. Cause and effect relationships are seldom given, and when proposed are of general nature with little quantitative value.

3.4 Statistical Inference. The statistical inferences drawn from approximately 1496 accidents/incidents are shown below. It should be noted that these figures include accidents/incidents of explosives, propellants, and pyrotechnics and constitute only those accounts which the author has personnally abstracted to date. (1, 2, 3, 4, 5, 6, 7)

Table 1 shows that the majority of the incidents were thermal in nature and this was because the emphasis of the survey was placed upon pyrotechnics.

Table 1. Accident/Incident Summary Inclusive of Explosives, Propellants, and Pyrotechnics (1950 through 1974)

Explosions	Explosions/Fire or Fire/Explosions	Fire	Other	Total
304	94	929	169	1496

Further breaking these figures down into life cycles which are broadly defined as: development (which included experimental, some testing, and laboratory operation); manufacturing operation; storage and transport; and use or ultimate consumption (see Table 2).

Table 2. Accident/Incident Summary Inclusive of Explosives, Propellants and Pyrotechnic as a Function of Life Cycle (1950 through 1974)

Operation	Explosion	Fire/Explosion or Explosion/Fire	Fire	Other	Total
Development	52	11	27	14	104
Manufacturing	210	68	522	99	899
Storage/ Transport	25	13	376	28	442
Ultimate Consumption	17	2	4	28	51
Totals	304	94	929	169	1496

As noted in table 2 the major portion of incidents/accidents are occurring during the manufacturing process where handling and classification of the material is at the discretion of the manufacturer.

Tables 3 through 13 are a breakdown of each operation as a function of the operation, type incident, severity, and stimulus.

Table 14 through 19 are summarized data from a GO-GO facility and a GO-CO facility. The emphasis is on the contrasting munition pyrotechnics versus HE manufacturer, but the most common stimulis in other cases is friction.

4.0 CONCLUSIONS

The results as tabulated herein are preliminary and constitute approximately 10 percent of the total reportable/non-reportable accidents/incidents of the same period. As noted the majority of accidents/incidents occur during the manufacturing process which is specifically excluded from the Hazardous Classification Procedure Army Technical Bulletin 700-2. Of those incidents involving materials that are classified according to procedure, the number was too minimal to denote trends or point out inefficiences in the classification procedure. It was also evident that no major undertaking of amassing data or compiling statistical inferences has occurred since 1964.

5.0 RECOMMENDATIONS

Since there has not been any compilation of data since 1964 and the latest revision to the Hazardous Classification Procedure TB 700-2 occurred in 1968, it is paramount that such an undertaking should warrant a very high priority. The amassing of such data calls for complete cooperation between all branches of the service and all Government agencies. Finally, it is evident that the regulations that govern manufacturing should be looked at in the same depth as the classification procedure for transportation and handling.

Specific recommendations are:

- Continue work effort as we have only scratched the surface.
- Code and computerize the data as the number is too much for a single individual to begin to statistically manipulate.
- Use this data for future Fault Tree Analysis type work.
- Disseminate field report to the proper agencies.

Table 3. Function Versus Type Incident of Accidents/Incidents During Development/Laboratory Operations Inclusive of Propellants, Pyrotechnics, Explosives, and Intermediate Constituents From 1950 through 1974.

Function	Explosion	1-C-T	Fire	Other	Total
Experimental	5	0	0	0	5
Testing	8	1	5	3	17
Laboratory Operations	24	4	18	7	53
Disposal	2	1	2	0	5
Maintenance	6	0	1	0	7
Storage and Handling	7	5	1	4	17
Totals	52	11	27	14	104

Table 4. Total Incident/Accident With Percentage of Total, Percent of Injury, Total and Average Cost of Development/Laboratory Operations 1950 through 1974.

Total Number Incidents	Number Incidents	Percent of Total Incidents	Personnel Injury			Total Cost $	Avg. Cost/ Incident
			Death	Lost Time	No Lost Time		
1496	104	6.9%	3.8	31.7	23	N/A	N/A

Table 5. Accident/Incident Summary Inclusive of Explosives, Propellants, Pyrotechnics, and Intermediate Constituents from 1950-1974 During Laboratory and Development Operations

Function	Type				Severity					Stimulus								
	Explosions	1-C-T	Fires	Other	Deaths Only	Deaths & Injury	Lost Time Injury	No Lost Time Injury	No Injury	Heat	Chemical	Electro-static	Friction	Pressure	Electrical	Impact	Other	Totals
Experimental	5	0	0	0	0	0	2	0	3	0	5	0	0	0	0	0	0	5
Testing	8	1	5	3	2	0	4	6	5	4	4	1	3	1	1	3	0	17
Laboratory Operations	24	4	18	7	0	2	14	11	26	15	17	4	6	4	2	2	4	53
Disposal	2	2	2	0	0	0	0	1	5	0	5	1	0	0	0	0	0	6
Maintenance	6	0	1	0	0	1	0	2	4	0	7	0	0	0	0	0	0	7
Storage and Handling	7	4	1	4	0	0	3	5	8	1	6	0	0	0	3	4	2	16
Totals	52	11	27	14	2	3	23	25	51	20	44	6	9	5	6	9	6	104

Table 6. Function Versus Type of Incident of Manufacturing Accident/ Incident Survey Inclusive of Propellant, Pyrotechnics, Explosives, and Intermediate Constituents from 1950 through 1974

Function	Explosions	1-C-T	Fires	Other	Totals
Testing	6	1	1	2	10
Material Preparation	32	12	132	6	182
Operations	121	34	308	42	505
Handling Packout Assy	9	9	22	13	53
Rework	6	3	7	1	17
Inspection	3	0	2	0	5
Maintenance	22	7	11	32	72
Disposal	7	2	3	1	13
Other	4	2	35	1	42
Totals	210	70	521	98	899

Table 7. Total Incident/Accident with Percentage of Total, Percent of Injury, Total and Average Cost of Manufacturing Operations 1950 through 1974

Total Number of Incidents	Number of Incidents	Percent of Total Incidents	Personnel Injury in Percent			Total Cost $	Avg. Cost/ Incidents
			Death	Lost Time	No Loss Time		
1496	899	60	4.2	5.3	10.6	N/A	N/A

Table 8. Function Versus Type Incident of Accident/Incident During Storage and Transportation Operations Inclusive of Propellants, Pyrotechnics, Explosives, and Intermediate Constituents from 1950 through 1974.

Function	Explosion	1-C-T	Fire	Other	Totals
Truck Loading Unloading	2	2	2	9	15
Truck in Route	0	1	1	3	5
Rail Loading Unloading	2	0	0	9	11
Rail in Route	14	2	369	2	387
General Storage	5	2	4	0	11
Storage-Handling	2	4	1	6	13
Totals	25	11	377	29	442

Table 9. Total Incident/Accident with Percentage of Total, Percent of Injury, Total and Average Cost and Transportation Incidents 1950 through 1974.

Total Number of Incidents	Number of Incidents	Percent of Total Incidents	Personnel Injury in Percent			Total Cost $	Avg. Cost / Incident
			Death	Lost Time	No Lost Time		
1496	442	29.6	1.1	1.4	1.8		

Table 10. Accident/Incident Summary Inclusive of Propellants, Pyrotechnics, Explosives, and Intermediate Constituents From 1950-1974 During Storage and Transportation Operations

Function	Type				Severity					Stimulus								
	Explosion	1-C-T	Fire	Other	Death	Death Injury	Lost Time Injury	No Lost Time Injury	No Injury	Heat	Chemical	Electro-static	Friction	Pressure	Electrical	Impact	Other	Totals
Truck Loading/ Unloading	2	2	2	9	1	1	4	4	5	0	1	1	1	3	0	5	4	15
Truck In Route	0	1	1	3	1	2	0	0	2	0	0	0	2	0	0	1	2	5
Rail Loading/ Unloading	2	0	0	9	0	0	0	6	5	0	2	0	0	4	0	0	5	11
Rail In Route	14	2	369	2	0	0	3	0	1	1	0	0	1	0	0	1	1	4
General Storage	5	2	4	0	1	1	1	0	8	0	4	0	0	1	1	0	5	11
Storage and Handling	2	4	1	6	2	2	0	2	7	1	5	2	0	0	0	4	1	13
Totals	25	11	377	29	5	6	8	12	28	2	12	3	4	8	1	11	18	59

Table 11. Function Versus Type Incident of Accidents/Incidents During Ultimate Use Inclusive of Propellants, Pyrotechnics, Explosives, and Intermediate Constituents from 1950 through 1974

Function	Explosions	1-C-T	Fire	Other	Total
Testing and Training	5	2	0	5	12
Operations	4	0	2	2	8
Disposal	3	0	1	1	5
Maintenance	4	0	0	5	9
Rework	1	0	0	0	1
Demil	0	0	1	0	1
Storage and Handling	0	0	0	15	15
Totals	17	2	4	28	51

Table 12. Total Incident/Accident with Percentage of Total, Percent of Injury Total and Average Cost of Ultimate Use Operations 1950 through 1974

Total Number of Incidents	Number of Incidents	Percent of Total Incidents	Personnel Injury in Percent			Total Cost $	Avg. Cost/ Incident
			Death	Lost Time	No Lost Time		
1496	51	3.5	9.8	5.9	15.7	378,500	742.15

Table 13. Accident/Incident Summary Inclusive of Propellants, Pyrotechnics, Explosives, and Intermediate Constituents from 1950-1974 During Ultimate Use Operations

Function	Type				Severity					Stimulus								
	Explosion	1-C-T	Fire	Other	Death Only	Death & Injury	Lost Time Injury	No Lost Time Injury	No Injury	Heat	Chemical	Electro-static	Friction	Pressure	Electrical	Impact	Other	Totals
Testing and Training	5	2	0	5	1	2	3	2	4	2	1	1	1	2	1	4	0	12
Operations	4	0	2	2	0	1	2	0	5	0	2	0	0	2	0	3	1	8
Disposal	3	0	1	1	0	0	2	2	1	3	0	0	0	0	1	1	0	5
Maintenance	4	0	0	5	3	0	1	0	5	1	0	0	0	1	4	3	1	9
Rework	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1
Demil	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1
Storage and Handling	0	0	0	15	0	0	0	0	15	0	0	0	0	0	1	0	14	15
Totals	17	2	4	28	5	3	8	4	31	6	4	1	2	5	7	11	16	51

Table 14. Function Versus Type Incident of Manufacturing Accident/Incident Survey Inclusive of Propellants, Pyrotechnics, Explosives, and Intermediate Constituents of a GO-GO Ammunition Plant from 1950 through 1974

Function	Explosions	1-C-T	Fire	Other	Totals
Testing	0	0	1	0	1
Operations	41	7	278	2	328
Rework	0	0	5	1	6
Preparation	5	0	82	0	87
Maintenance	1	0	2	2	5
Handling	0	1	9	0	10
Other	4	0	35	0	39
Totals	51	8	412	5	476

Table 15. Total Incident/Accident with Percentage of Total, Percent of Injury, Total and Average Cost of Manufacturing Operations of a GO-GO Ammunition Plant 1950 through 1974

Total Number of Incidents	Number of Incidents	Percent of Total Incidents	Personnel Injury in Percent			Total Cost $	Avg. Cost /Incident
			Death	Lost Time	No Lost Time		
1496	476	31.8	0.2	0.6	0.6	47,800	100.00

Table 16. Accident/Incident Summary of GO-GO Pyrotechnic Production Facility from 1950-1974

Function	Type				Severity					Stimulus							
	Explosion	1-C-T	Fire	Other	Death Only	Death & Injury	Lost Time Injury	No Lost Time Injury	No Injury	Heat	Chemical	Friction	Pressure	Electro-Static	Impact	Other	Totals
Testing	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	1
Operations	41	7	278	2	0	0	3	0	138	0	5	234	29	18	11	31	328
Rework	0	0	5	1	0	0	0	0	6	1	0	0	0	0	5	0	6
Preparation	5	0	82	0	1	0	0	0	19	1	3	36	0	13	9	25	87
Maintenance	1	0	2	2	0	0	0	2	3	0	0	2	1	0	0	2	5
Handling	0	1	9	0	0	0	0	0	10	1	2	1	1	0	4	1	10
Other	4	0	35	0	-	-	-	-	-	0	0	19	0	1	4	15	39
Totals	51	8	412	5	1	0	3	3	176	3	10	292	31	32	33	75	476

Table 17. Function Versus Type Incident of Manufacturing Accident/Incident Survey Inclusive of Propellants, Pyrotechnics, Explosives, and Intermediate Constituents of a GO-CO Ammunition Plant from 1972 through 1975.

Function	Explosions	1-C-T	Fire	Other	Totals
Operations	37	3	1	1	42
Inspection	2	0	0	0	2
Rework	3	0	0	0	3
Maintenance	3	1	1	0	5
Handling, Packout, Assembly	3	0	0	2	5
Totals	48	4	2	3	57

Table 18. Total Incident/Accident with Percentage of Total, Percent of Injury, Total and Average Cost of Manufacturing Operations of a GO-GO Ammunition Plant from 1972-1975.

Total Number of Incidents	Number of Incidents	Percent of Total Incidents	Personnel Injury in Percent			Total Cost $	Avg. Cost /Incident
			Death	Lost Time	No Lost Time		
1496	57	3.8	0	5.3	14	168,575	2,987.46

Table 19. Accident/Incident Summary Inclusive of Pyrotechnics, Propellants, and Explosives (1972-1975) of Contractor Operated Ammunition Plant.

Function	Type				Severity					Stimulus						
	Explosion	1-C-T	Fire	Other	Death Only	Death & Injury	Lost Time Injury	No Lost Time Injury	No Injury	Heat	Chemical	Friction	Pressure	Impact	Other	Totals
Operations	37	3	1	1	0	0	1	5	36	2	0	23	1	12	4	42
Inspection	2	0	0	0	0	0	1	1	0	0	0	1	0	1	0	2
Rework	3	0	0	0	0	0	0	1	2	0	0	0	1	2	0	3
Maintenance	3	1	1	0	0	0	1	0	4	0	1	3	0	1	0	5
Handling, Packout, Assembly	3	0	0	2	0	0	0	1	4	0	0	0	1	2	2	5
Totals	48	4	2	3	0	0	3	8	46	2	1	27	3	18	6	57

REFERENCES CITED

1. AD 660-020, Explosives Accident/Incident Abstracts, Armed Services Explosives Safety Board, Washington, D.C., October 1967.

2. Historical Summary Safety Data Pertinent to Manufacturing and Loading of Solid Propellants, May 1964.

3. NSTB-RAR-75-4, NSTB-RAR-75-7, NSTB-RAR-75-2, National Transportation Safety Board Reports.

4. Transportation of Military Ammunition and Explosives, Minutes of the Sixteenth Explosives Seminar, Volume 2, pp 591-615, J. H. Edgerton.

5. U.S. Army Materiel Command Field Safety Agency Abstracts, Charleston, Indiana.

6. Dust Explosives Analysis and Control, Factory Insurance Association, 11-66.

7. 530 previously unreported incidents, gathered by Author.

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